INVENTORY AND POPULATION CHARACTERIZATION STUDY OF BARSTOW WOOLLY SUNFLOWER ON EDWARDS AIR FORCE BASE, CALIFORNIA

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Abstract: Surveys were conducted for Barstow woolly *sunflower* (*Eriophyllum mohavense*) *in* Spring 1995 on Edwards Air Force Base, California. These surveys were conducted in three previously known populations and in 47 areas of potential habitat to document the presence or absence of Barstow woolly sunflower on the base and to determine the number of individuals and population areas of the species on the base. Surveys detected 98,760 Barstow woolly sunflowers in populations of up to 82,183 plants in population areas of up to 15 hectares, although many subpopulations were less than 0.025 hectares in area. A detailed survey consisting of three observation periods and two population size surveys were conducted in previously known populations. Seventy percent of the measured samples were in bud or bud and flower during Observation A, 94 percent were in flower during Observation B, and 91 percent were in fruit or past the fruiting stage during Observation C. A total of 3,635 individuals were found during the two population size surveys. Seventeen populations were found during the 47 potential habitat surveys. The newly reported populations were found within the previously reported geographic range of the species on the base. Ninety-five percent of the populations were found in zonal habitats of halophytic phase saltbush scrub with one population in Joshua tree woodland zonal habitat with halophytic phase saltbush scrub understory. The most common azonal habitat, clay pan, was reported in 85 percent of the survey areas where Barstow woolly sunflower was found. Seventy-five percent of the populations were found in association with alluvial plain geomorphology. Clay and silt soil components were the dominant soil textures found. No incidental detections occurred on the base during the Spring 1995 sensitive plant species surveys.

The Barstow woolly sunflower *(Eriophyllum mohavense*) is a spring-flowering, dwarf, woolly-villous annual in the sunflower family (Asteraceae). It forms small, dense, rounded tufts, 1 centimeter (cm) to 2.5 cm tall and usually only 1 to 3 cm wide (Munz 1974). The flower heads are very small, more or less sessile, each bearing three or four pale yellow tubular flowers about 2 millimeters (mm) long. The flowering period typically occurs in late March, April, or early May, depending on the weather conditions. After flowering, Barstow woolly sunflowers quickly go to seed, dry out, break apart, and are blown away, usually leaving no trace of their presence by May or early June. Illustrations of Barstow woolly sunflower and related species can be found in Hickman (1993) and Abrams and Ferris (1960). Barstow woolly sunflower is a federal category 2 candidate and is on the California Native Plant Society's (CNPS) list 1B, plants that are considered rare and endangered in California or elsewhere.

The previously reported distribution of Barstow woolly sunflower extends about 95 kilometers (km) west to east from the hills adjacent to Buckhorn Dry Lake on Edwards Air Force Base (AFB) to near Barstow, and about 40 km south to north from just beyond the southeastern corner of Edwards AFB to near Fremont Peak. Many of the previously reported populations were small, with few plants observed at each site. A few populations with several thousand plants have been reported and population size can fluctuate tremendously from year to year, as is typical

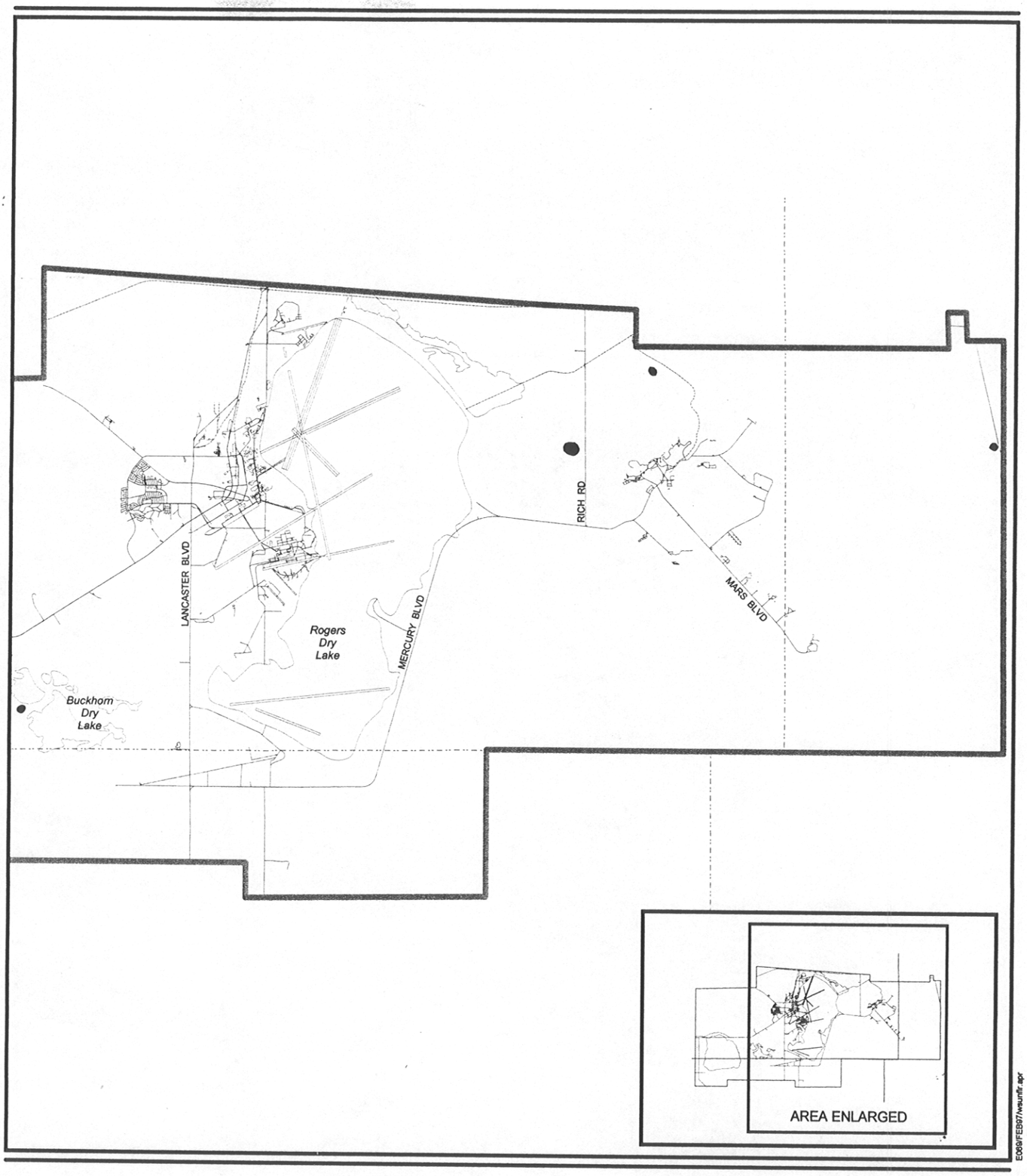
for desert annuals. Barstow woolly sunflower has been previously reported to occur in creosote bush scrub and arid phase saltbush scrub plant communities, sometimes with scattered Joshua trees as an overstory at elevations between about 500 and 1,100 m. This species often occurs in barren, open areas without shade from shrubs and with little competition from other plants. Common associates are pepper grass (*Lepidium flavum*) and Mojave spineflower (*Chorizanthe spinosa*), a CNPS watch list species (Skinner and Pavlik 1994; Charleton 1993b).

Prior to 1982, Barstow woolly sunflower had been recorded from two sites near Barstow, California. Between 1982 and 1986, 15 new populations were discovered between Barstow and Kramer Junction, and in 1987 seven more were discovered between Kramer Junction and Boron, north of Highway 58 (ERT 1988a). Since 1987, additional populations have been discovered north of Barstow (CDFG 1994), between Barstow and Kramer Junction (ERT 1988a; Dames and Moore 1993), and south of Kramer Junction, just west of Highway 395 (Dames and Moore 1993). Two populations of Barstow woolly suntlower were first identified on Edwards AFB in 1991 during spring surveys of potential habitat on the base (Charlton 1993a). By 1993, four widely spaced populations had been reported on the base (Mitchell *et* al. 1993) (Figure 1). The populations on Edwards AFB represent the westernmost extension of the species, with the population on the hills adjacent to Buckhom Lake about 27 km west of the nearest population.

The primary purpose of this survey was to determine the presence or absence of Barstow woolly sunflower in different areas of the base in 1995; and to determine the number of individuals, location, and extent of certain populations on Edwards AFB. This determination could aid in the development of a management plan to protect sensitive species with minimal impact to the Edwards AFB mission.

STUDY AREA

The study area for these surveys is consistent with the boundaries of Edwards AFB, California. Within the study area, 50 survey areas were determined in consultation with the base biologist (Figures 2 and 3, Table 1). Three of these were surveys of known populations of Barstow woolly sunflower: 1 detailed survey and 2 population size surveys. Forty-seven were established to survey areas of potential habitat for the species. All Barstow woolly sunflower survey areas were located within the previously known general range of the species on Edwards AFB.



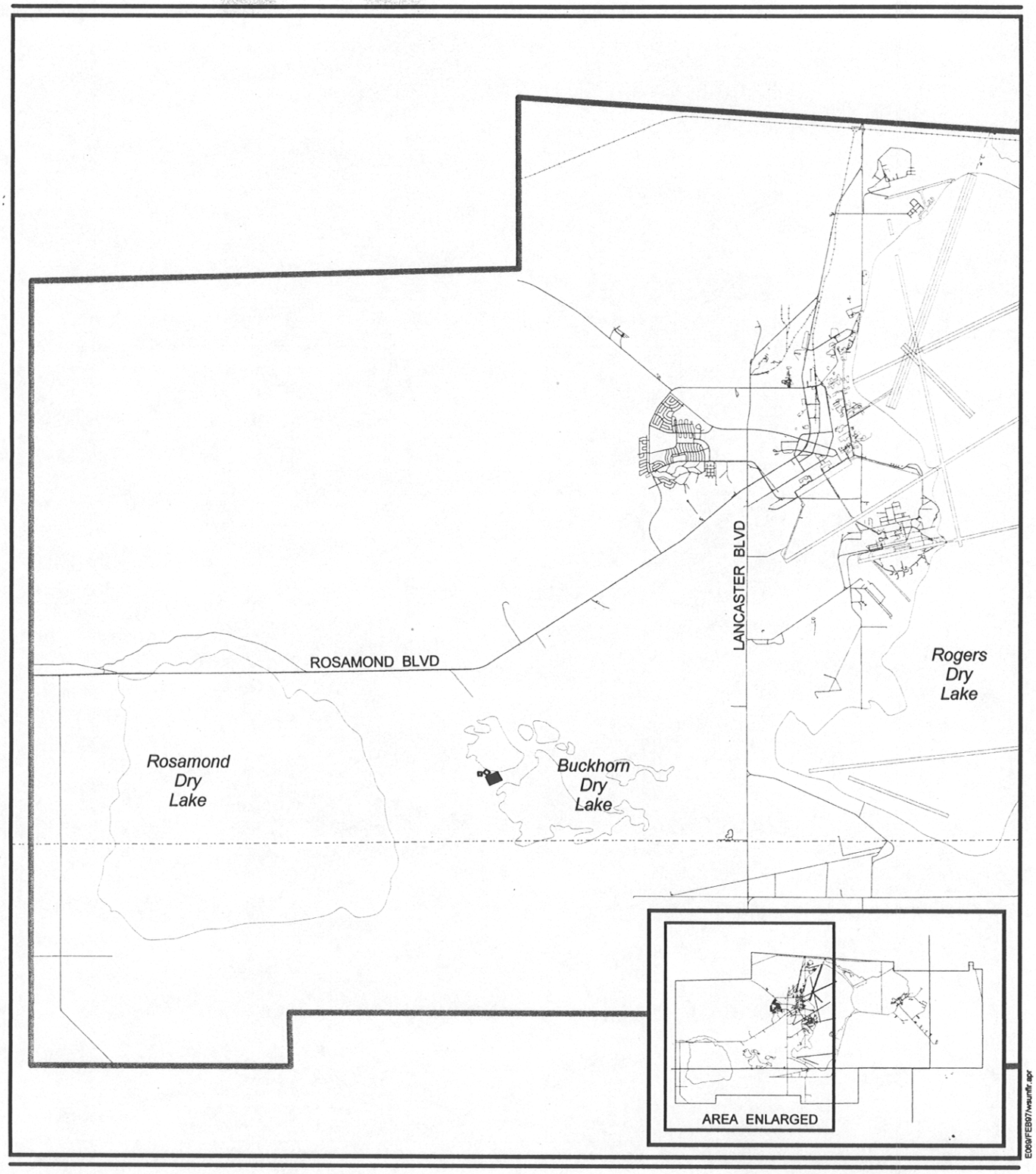
Base Boundary

Barstow Woolley Sunflower Population

10000 0 10000 Feet

Previously Reported Populations of Barstow Woolly Sunflower on Edwards Air Force Base

Figure 1



Study Area Boundary (Base Boundary)

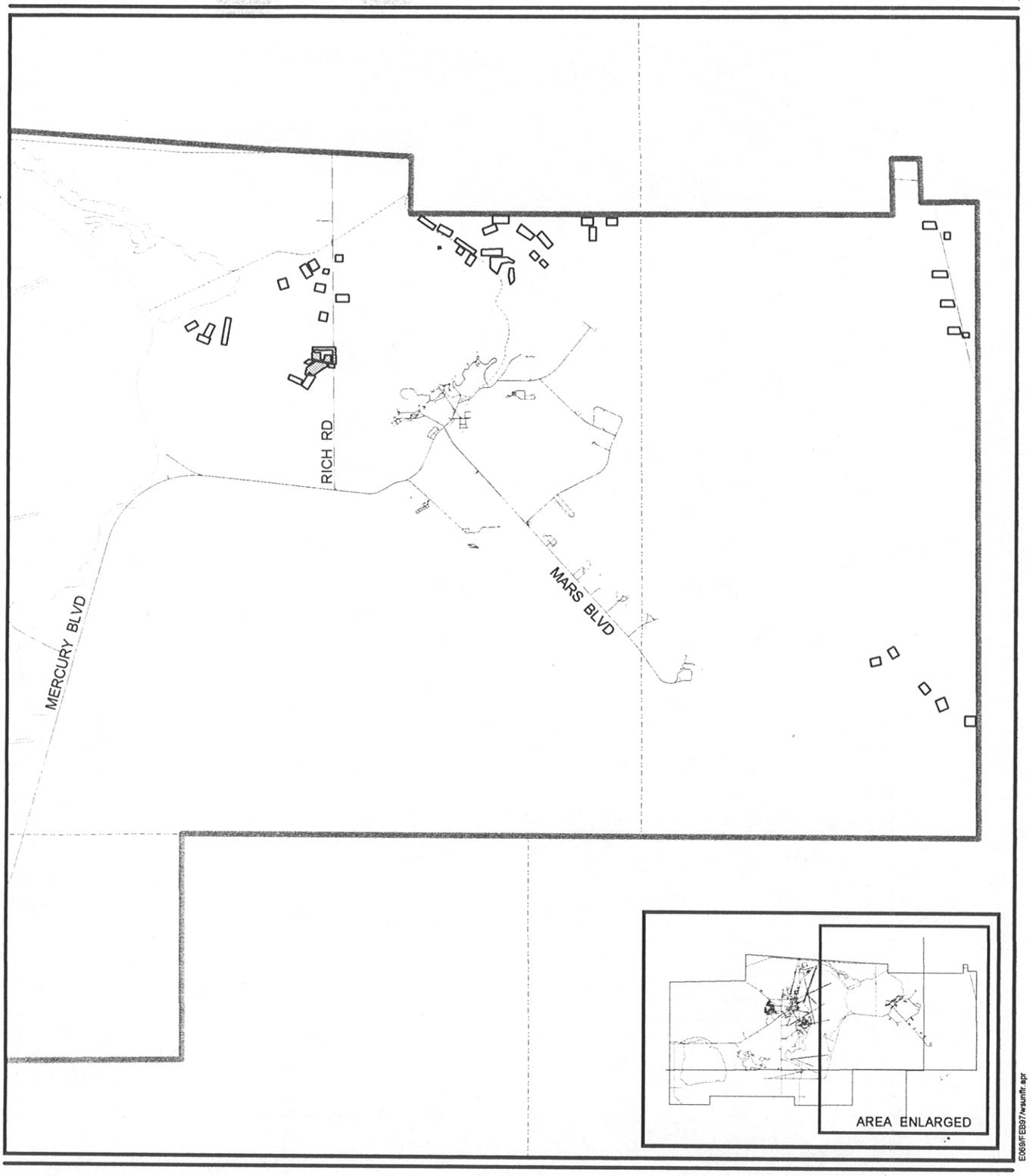
Population Size Survey Area

Potential Habitat Survey Area

5000 0 5000 10000 Feet

Barstow Woolly Sunflower Study Area and Survey Areas West Edwards AFB

Figure 2



Study Area Boundary (Base Boundary)
Detailed Survey Area
Population Size Survey Area
Potential Habitat Survey Area

5000 0 5000 10000 Feet

Barstow Woolly Sunflower Study Area and Survey Areas East Edwards AFB

Figure 3

Table 1

Locations of *Eriophyllum mohavense* Survey Areas

Survey Area	1/4 Section	Section	Range	Township	USGS Quad
95RP004	SW	21	8W	10N	Leuhman Ridge
95RP014	SW	11	8W	10N	Leuhman Ridge
95RP036	SE	25	11W	9N	Redman
95RP1001	SE	25	11W	9N	Redman
95RP3003	NW	12	8W	10N	Leuhman Ridge
95RP3005	NE	12	8W	10N	Leuhman Ridge
	NW	7	7W	10N	Leuhman Ridge
95RP3006	NW	19	8W	10N	Rogers Lake North
95RP3007	SW	18	8W	10N	Rogers Lake North
	NW	19	8W	10N	Rogers Lake North
95RP3008	NE	19	8W	10N	Rogers Lake North
95RP3009	SE	21	8W	10N	Leuhman Ridge
95RP3010	SW	9	8W	10N	Leuhman Ridge
	NW	16	8W	10N	Leuhman Ridge
95RP3011	NW	19	8W	10N	Rogers Lake North
	SW	18	8W	10N	Rogers Lake North
95RP3012	SW	21	8W	10N	Leuhman Ridge
95RP3013	SW	9	8W	10N	Leuhman Ridge
	NW	16	8W	10N	Leuhman Ridge
95RP401	SW	21	8W	10N	Leuhman Ridge
95RP402	SE	20	8W	10N	Leuhman Ridge
95RP403	NW	21	8W	10N	Leuhman Ridge
95RP404	SW	12	8W	10N	Leuhman Ridge
95RP405	SE	12	8W	10N	Leuhman Ridge
95RP406	SE	12	8W	10N	Leuhman Ridge
	NE	13	8W	10N	Leuhman Ridge
95RP407	SE	17	6W	10N	Leuhman Ridge
95RP408	SW	17	6W	10N	Leuhman Ridge
95RP409	SW	8	6W	10N	Leuhman Ridge
95RP410	NE	20	6W	10N	Leuhman Ridge
95RP411	NW	8	6W	10N	Leuhman Ridge
95RP412	NW	8	6W	10N	Leuhman Ridge
95RP413	NW	7	7W	10N	Leuhman Ridge
95RP414	NE	11	8W	10N	Leuhman Ridge
95RP415	NW	12	8W	10N	Leuhman Ridge
95RP416	SW	7	7W	10N	Leuhman Ridge
95RP417	SW	7	7W	10N	Leuhman Ridge
95RP5001	SW	20	6W	9N	Red Buttes
95RP5002	SE	20	6W	9N	Red Buttes
95RP5003	NE	19	6W	9N	Red Buttes
95RP5004	SW	18	6W	9N	Red Buttes
95RP5005	SW	18	6W	9N	Red Buttes
95RP5054	NW	8	7W	10N	Leuhman Ridge
95RP5055	NW	8	7W	10N	Leuhman Ridge
95RP5056	NW	8	7W	10N	Leuhman Ridge
95RP5057	SE	11	8W	10N	Leuhman Ridge
95RP5058	SE	11	8W	10N	Leuhman Ridge
95RP5059	NE	16	8W	10N	Leuhman Ridge
95RP5060	SE	9	8W	10N	Leuhman Ridge
95RP5061	NW	11	8W	10N	Leuhman Ridge
95RP5062	NE	11	8W	10N	Leuhman Ridge
95RP5063	NE	17	8W	10N	Leuhman Ridge
95RP5064	SW	9	8W	10N	Leuhman Ridge
95RP5065	NW	16	8W	10N	Leuhman Ridge
95RP5056	SW	16	8W	10N	Leuhman Ridge
95RP5067	SW	25	11W	9N	Redman

METHODS

These surveys were originally scheduled during Spring 1994; however, reconnaissance surveys revealed little or no germination of *Eriophyllum* species at known population sites, probably due to below average rainfall. After consultation with the base biologist, the surveys were postponed until the 1995 growing season. Field investigations were conducted between March 15 and May 5, 1995 when Barstow woolly sunflower was expected to be evident and identifiable and to coincide with known flowering and fruiting periods.

Three types of surveys were conducted: 1 detailed survey, 2 population size surveys, and 47 potential habitat surveys. The detailed survey was conducted within a known population to record the size and location of the population and to collect individual plant data that will characterize aspects of plant growth and distribution. Population size surveys were conducted to record the area and number of individuals in known populations and to delineate population boundaries using global positioning systems (GPS) technology. Potential habitat surveys were conducted to determine the presence or absence and number of individuals in selected areas of the base,

Trimble GeoExplorer™ GPS receivers were used to delineate the location of each survey area boundary. Other features recorded were areas, points, and lines indicating plant population locations. For populations larger than 50 square meters, the population boundary was recorded as a polygon. For populations smaller than 50 square meters, a single point near the center of the population was recorded. For populations that were linear (such as those found in a drainage) the population was recorded as a line. Data requirements for these surveys were collected in accordance with the Edwards AFB Geographic Information System (GIS) data dictionary. Table 2 summarizes the types of data collected for the surveys of known populations (detailed and population size surveys) and potential habitat surveys, along with the method used in the collection of that data. Survey areas were located with the assistance of botanist David Charlton using U.S. Geological Survey (USGS) maps. Transect orientation was established and maintained by use of compass and flagging tape. Field forms developed by the CNPS were completed for each population.

Surveys of Known Populations

Two types of surveys, one detailed survey and two population size surveys, were conducted at known populations, selected in consultation with the base biologist. Survey areas were consistent with the previously reported boundary of the Barstow woolly sunflower population. Transects were extended by 50 meters (m) when individuals were observed beyond the boundary as described in the work plan for these surveys. The locations where populations extended outside the survey area were suggested as sites for potential habitat surveys.

Table 2

Data Requirements and Methods

Data Requirements	Surveys of Known Populations	Potential Habitat Surveys	Methods and Units
Observation date	*	*	Actual date
Start and end time of each survey period	*	*	By 24-hour clock
Surveyor(s) initials	*	*	First and last initial
Survey Area identifier (ID)	*	*	A 7 or 8-digit alphanumeric including year of survey, "RP" for rare plant, and unique numeric identifiers for each population.
Transect ID	*	*	A 7 or 8-digit alphanumeric including year of survey, "EM" for *Eriophyllum mohavense*, and unique numeric identifiers for each population.
Plant ID	*		A 3-digit number assigned in chronological order (001, 002, etc.)
Number of individuals	*	*	Counted in the field up to 500 using hand held tally counters or estimated if over 500
Phenological stage	*	*	CNPS definitions (percent in each class)
Habitat description for each survey area:			
Zonal habitat and azonal habitat	*	*	Zonal habitat read from vegetation maps of the base (Mitchell *et. al.*, 1993) or visually determined in the field; azonal habitat visually determined in the field
Associated plant species	*	*	Visually determined in field
Geomorphology	*	*	Visually determined in field using GIS domain table
Soil texture	*	*	Visually determined in field using GIS domain table
Slope	*	*	Measured in percentage with clinometer or estimated in the field
Aspect	*	*	Measured in degrees with compass
Weather conditions for each survey period:			
Maximum and minimum daily temperature	*	*	Measured in Celsius with standard scientific thermometer
Maximum daily wind speed	*	*	Estimated in the field
Wind direction	*	*	Estimated in the field
Maximum percent cloud cover	*	*	Estimated in the field
Location:			
County	*	*	County name
USGS quadrangle	*	*	USGS quad name
Township, range, and section	*	*	Read from USGS quad
Elevation	*	*	Read from USGS quad or determined from GPS data

Detailed Survey

A detailed survey for Barstow woolly sunflower was conducted in three observation periods during the growing season (Figure 3). Observation A was conducted between March 15 and 20 and on March 26, 1995; Observation B on April 11 and 12, 1995; and Observation C between May 3 and 5, 1995. Data were collected for 100 plants in 5 subpopulations (500 individuals total) during each visit (Table 2). Field surveys were conducted by systematically walking transects 5 m wide and the length of the survey area (approximately 400 m). The primary objectives of this survey were to record the size and location of subpopulations and to collect individual plant data that would characterize some aspects of plant growth and distribution over time.

The number of plants in the population was counted directly during Observation A. As the 5-meter survey transects were walked, pin flags were placed to indicate boundaries of plant occurrences or subpopulations. After all subpopulation boundaries were determined using 5-meter transect spacing, they were divided into belt transects measuring 1-meter wide, and direct counts were obtained for the entire population area.

During Observation B and Observation C, as the survey transects were walked, new subpopulations and extensions of previously determined boundaries were pin-flagged. To obtain population counts, all new subpopulations were assigned a number, and a random number generator selected one-third of all the subpopulations to be sampled by direct counts. After the newly selected subpopulations were sampled, and the average change in number of individuals was calculated and extrapolated to obtain a total population estimate.

To determine the individuals to be studied in detail, each subpopulation was assigned a number, and a random number generator selected five subpopulations. One hundred plants from each subpopulation were studied. If a selected subpopulation did not contain 100 plants, the balance was obtained from the subpopulation with the next higher number. The first 100 plants encountered were surveyed beginning at the center of the subpopulation and radiating outward in a spiral pattern.

Population Size Surveys

Two population size surveys were conducted to record the 1995 population area and number of individuals for each population and to delineate the population boundary using GPS technology. Population size surveys were conducted once for each population during the estimated peak of flowering. Population size surveys were conducted at two populations of Barstow woolly sunflower between April 4 and 7, 1995 (Figures 2 and 3).

Field surveys were conducted by systematically walking transects 5 m wide and the length of the survey area. The length of each survey are varied based on the extent of the previously-recorded Barstow woolly sunflower population. The number of plants and phenological stage in each population were recorded while transects were walked. To avoid double counting or missing plants, individuals near the margins of a transect were marked with flagging or pin flags. The number of Barstow woolly sunflowers were counted individually where plants were sparse or for small populations of isolated individuals. Where plants were dense, the number of plants in small

groups within a transect were visually estimated and recorded. All counts and estimates were combined to determine the estimated number of individuals in the population.

Potential Habitat Surveys

Surveys were conducted in 47 areas of potential habitat for Barstow woolly sunflower. The survey areas were determined in coordination with the base biologist and based on observations made during known population surveys (Figures 2 and 3). These surveys were conducted between April 4 and 25, 1995. The primary objective of these surveys was to determine the presence or absence of Barstow woolly sunflower in these areas. All potential habitat surveys were conducted by systematically walking transects 25 m wide and the length of the survey area. The length of each survey area varied because the boundary of the survey area was established when no individuals of Barstow woolly sunflower were observed within 50 m of the last individual. If Barstow woolly sunflower was found, transect width was reduced to 5 m. For each population of Barstow woolly sunflower identified during the potential habitat surveys, direct counts and phenological stages were recorded.

Incidental Detections

Other sensitive plant species that were observed during Barstow woolly sunflower surveys were recorded on USGS quadrangle maps in the field. For all incidental detections, the number of individuals and population size was estimated. There were no incidental detections of Barstow woolly sunflower during surveys for other sensitive plant species in Spring 1995.

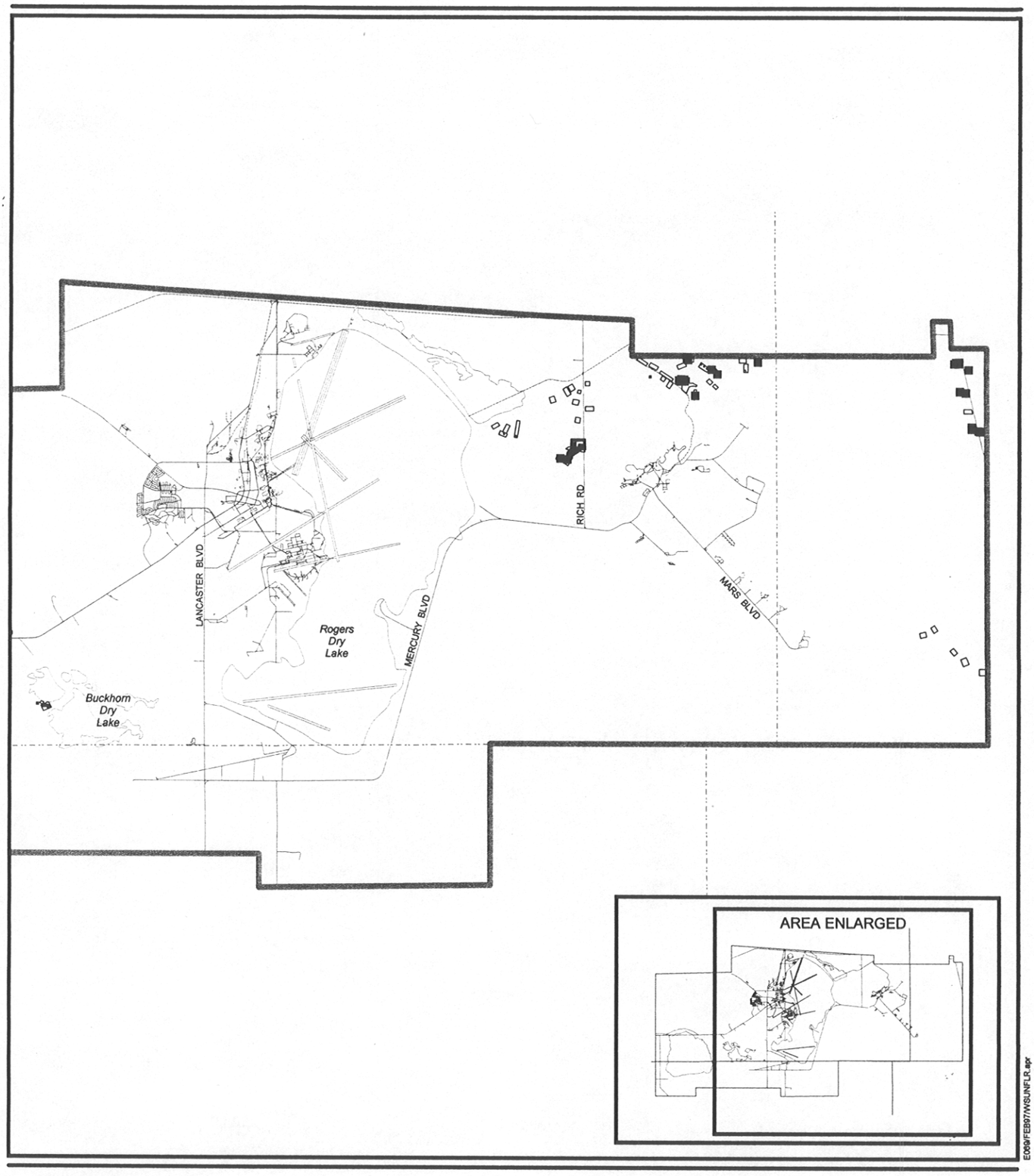
RESULTS

Figure 4 shows the survey area locations across the base for Barstow woolly sunflower and serves as a key map for Figures 5 through 10, which show more detailed views of the population areas of Barstow woolly sunflower. A total of 98,760 Barstow woolly sunflowers were counted or estimated throughout the survey areas (Table 3). The species was found in 20 of the 50 survey areas.

Table 3

Data Summary for *Eriophyllum mohavense* Surveys
Spring 1995

Survey Type	Total Number of Individuals	Number of Populations	Total Population Area (hectares)	Number of Survey Areas
Detailed	82,183	1	15.0	1
Population Size	3,635	2	1.6	2
Potential Habitat	12,942	17	5.4	47
Total:	98,760	20	22.0	50



Base Boundary

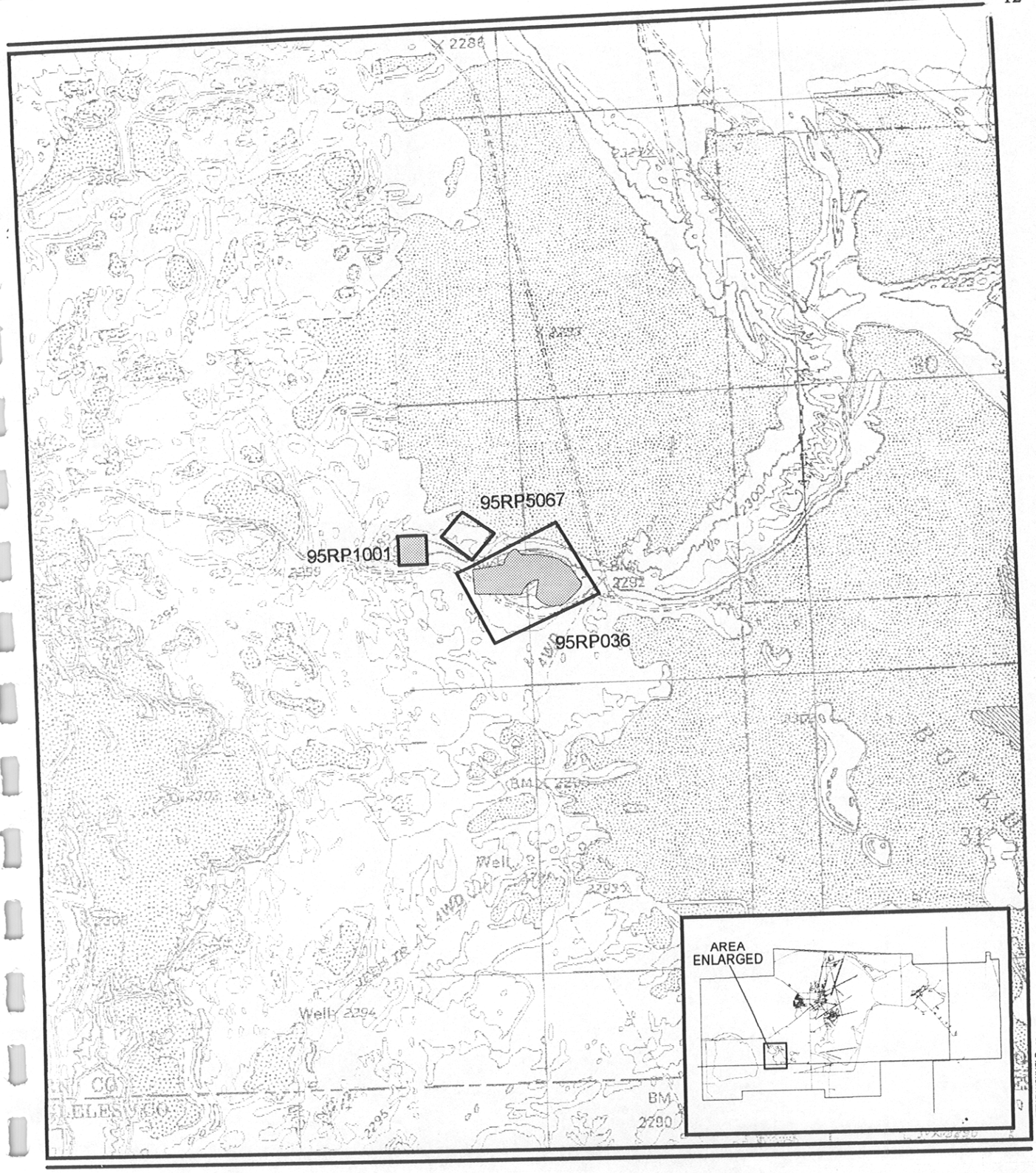
Survey Area Boundary

Population

10000 0 10000 Feet

Populations of Barstow Woolly Sunflower on Edwards AFB

Figure 4



Base Boundary

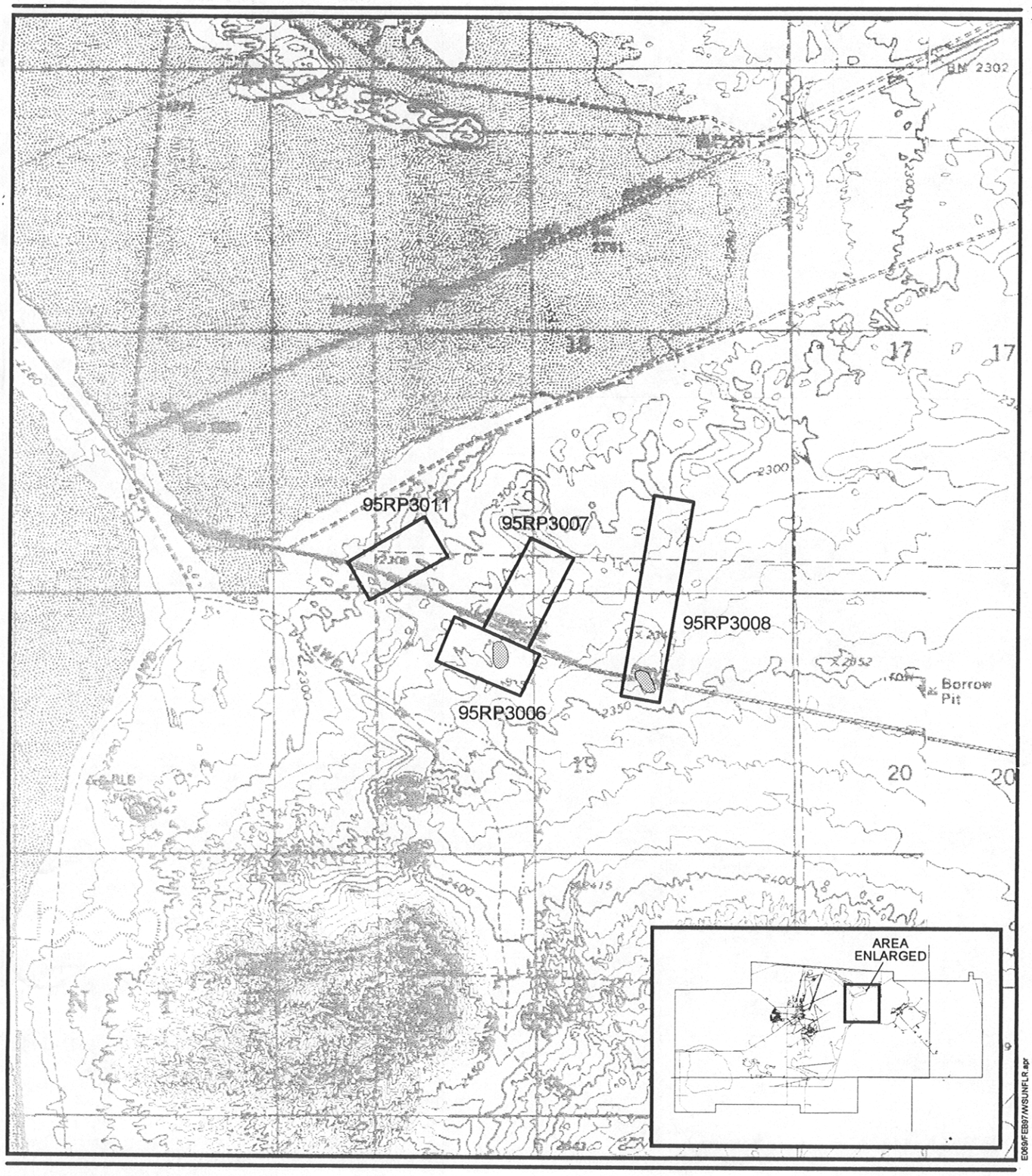
Survey Area Boundary

Population > 50 Square Meters

1000 0 1000 Feet

Populations of Barstow Woolly Sunflower on Edwards AFB

Figure 5



Base Boundary

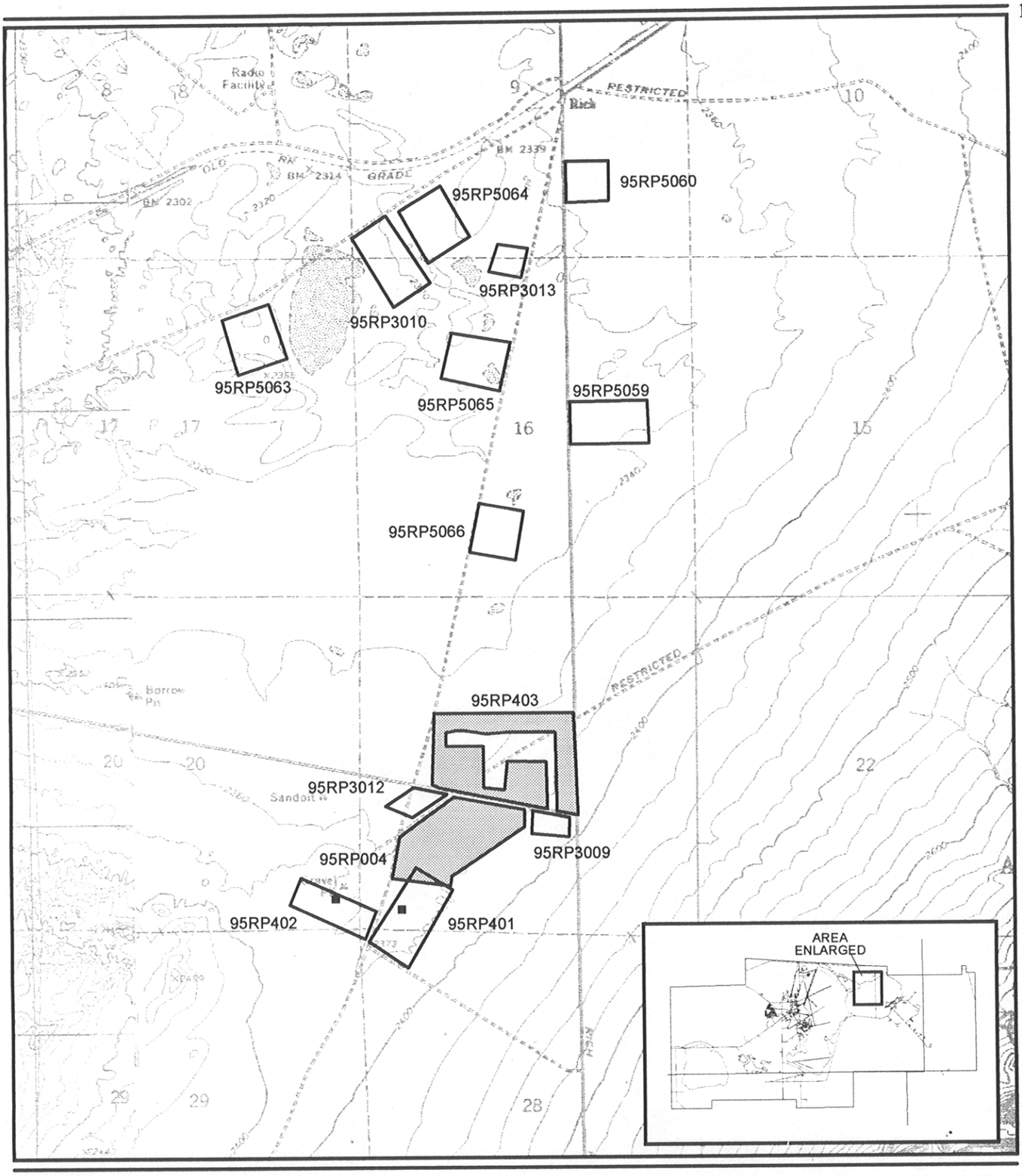
Survey Area Boundary

Population > 50 Square Meters

1000 0 1000 Feet

Populations of Barstow Woolly Sunflower on Edwards AFB

Figure 6



Base Boundary

Survey Area Boundary

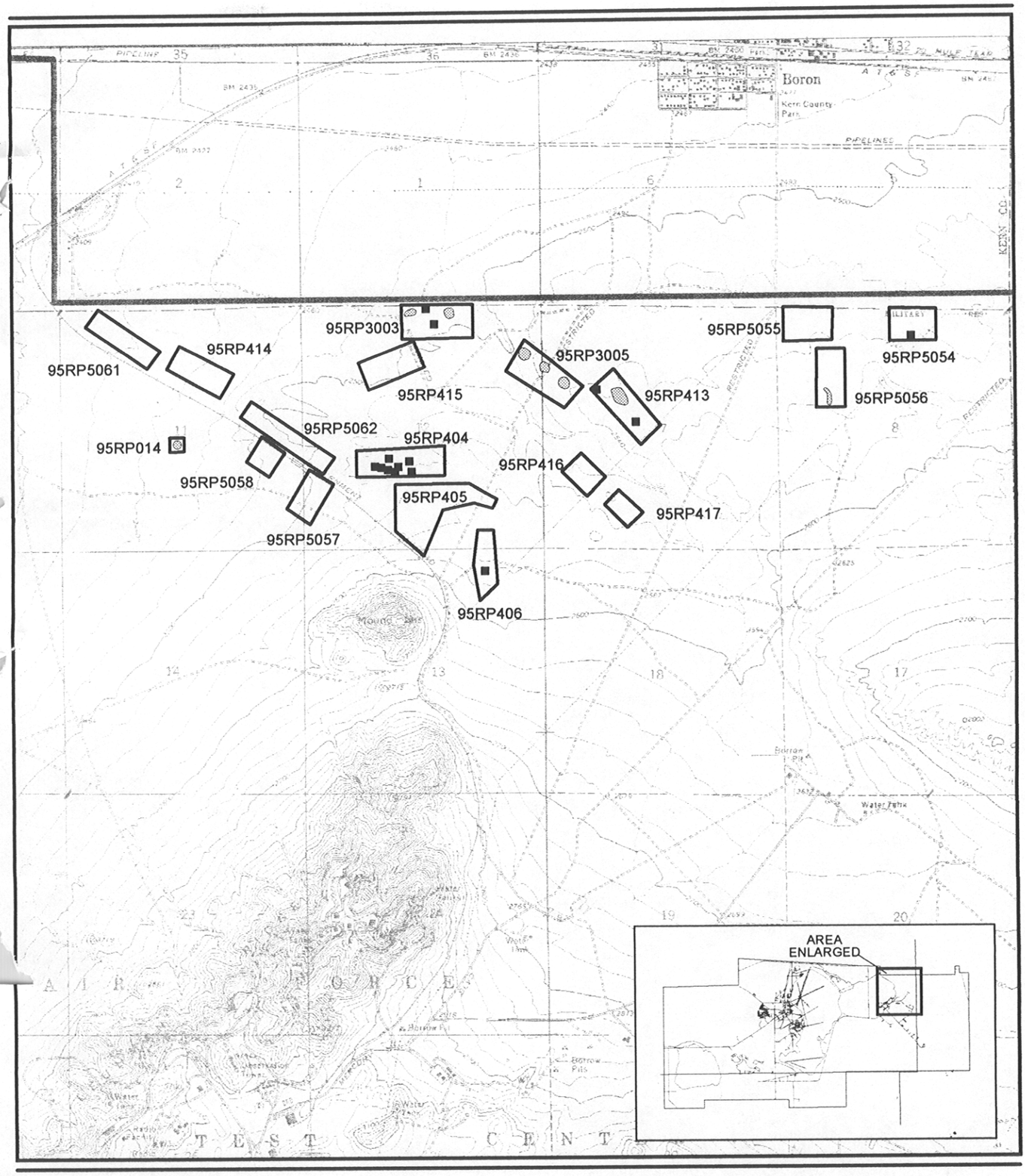
Population > 50 Square Meters

Population ≤ 50 Square Meters

1000 0 1000 Feet

Populations of Barstow Woolly Sunflower on Edwards AFB

Figure 7



Base Boundary

Survey Area Boundary

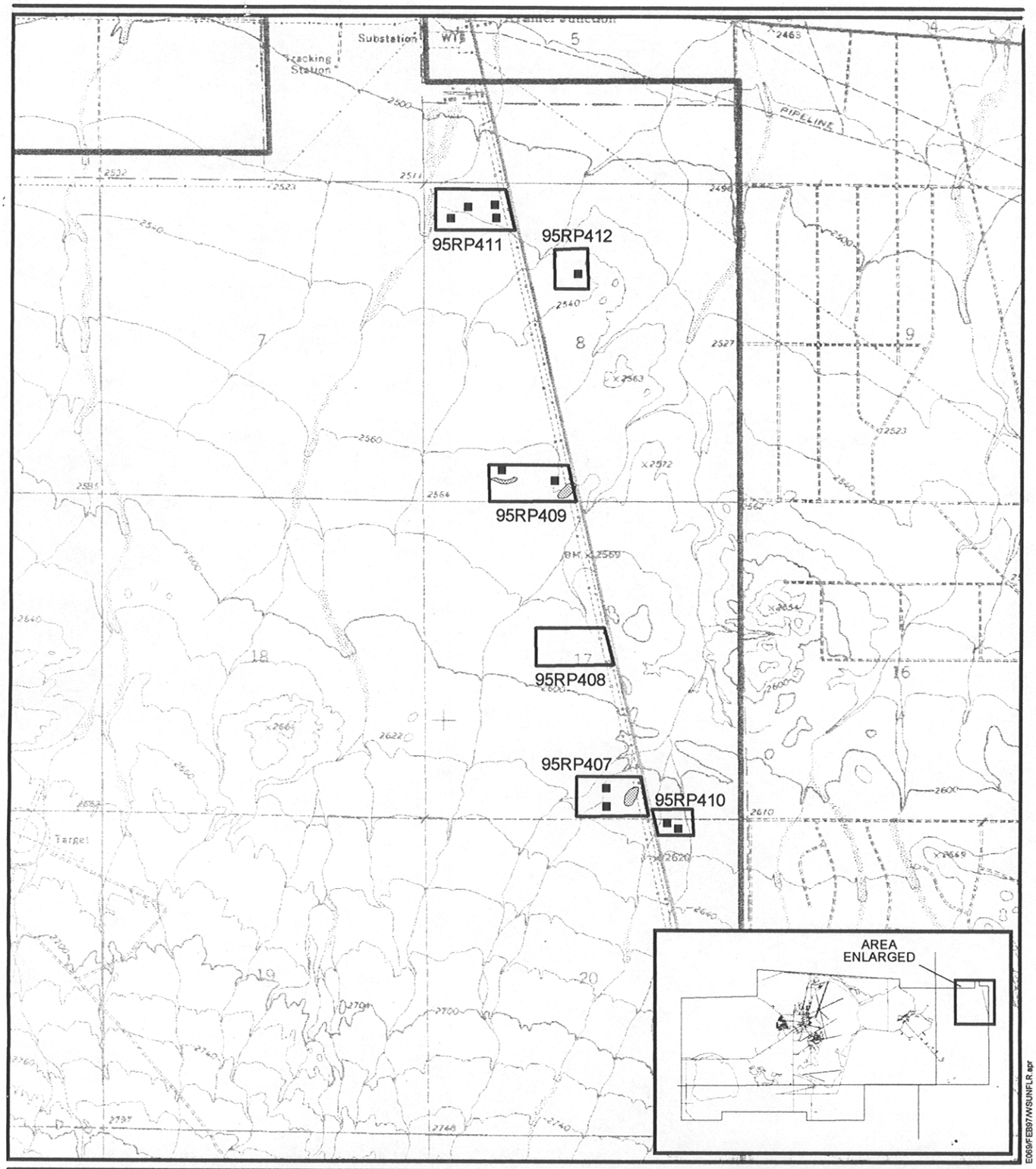
Population > 50 Square Meters

Population ≤ 50 Square Meters

1000 0 1000 2000 Feet

Populations of Barstow Woolly Sunflower on Edwards AFB

Figure 8



Base Boundary

Survey Area Boundary

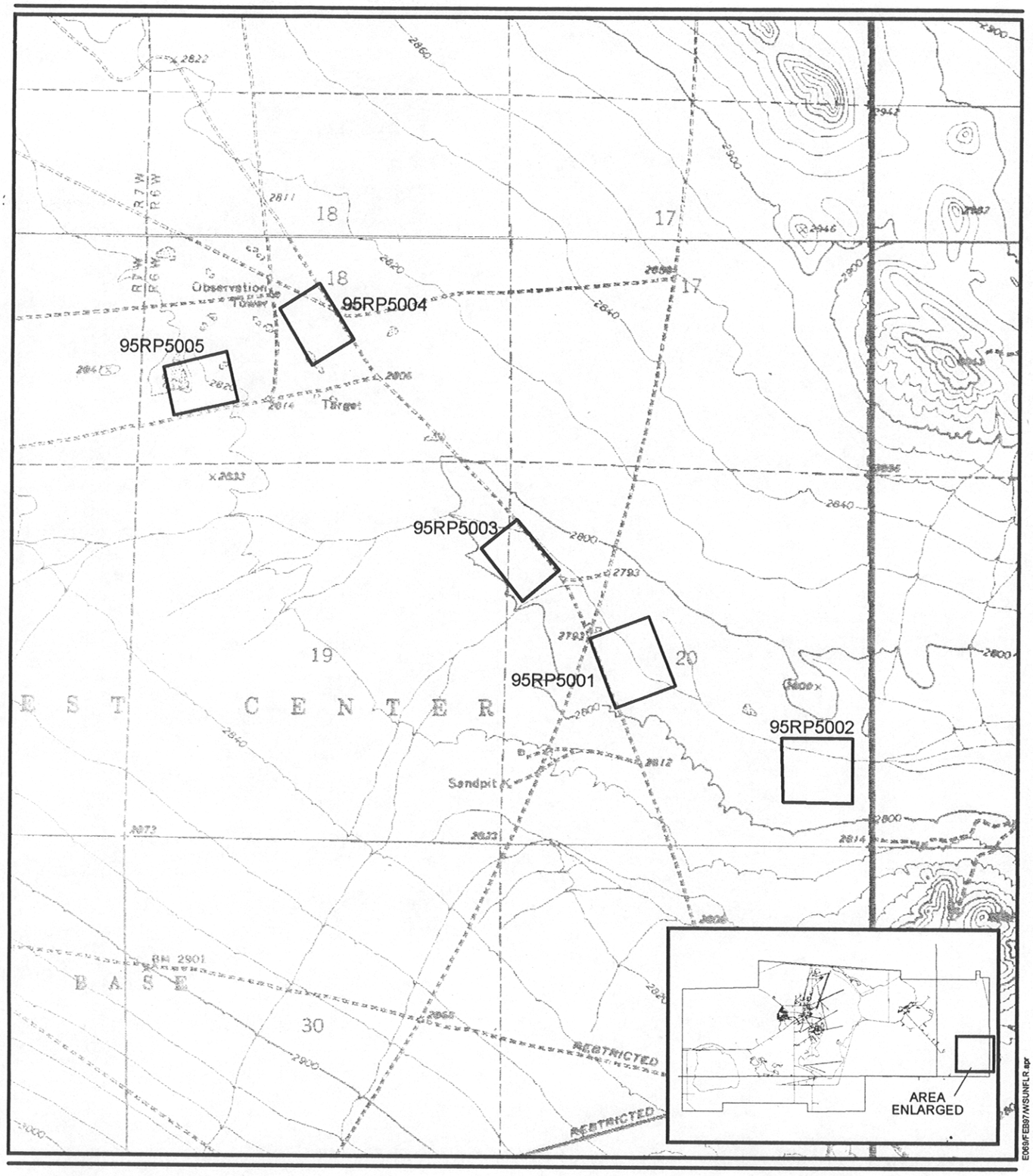
Population > 50 Square Meters

Population ≤ 50 Square Meters

1000 0 1000 Feet

Populations of Barstow Woolly Sunflower on Edwards AFB

Figure 9



Base Boundary

Survey Area Boundary

Populations of Barstow Woolly Sunflower on Edwards AFB

1000 0 1000 Feet

Figure 10

Population sizes ranged from 29 to 3,124 plants, excluding the detailed survey area where a peak of 82,183 plants were estimated during Observation B. Population areas were generally small, ranging from 0.0045 to 1.6 hectares (ha), excluding the detailed survey area which covered approximately 15 ha. The plants in these population areas were not evenly distributed, but were generally clumped into subpopulations. Thirty-seven subpopulations were recorded in 8 of the survey areas and 35 subpopulations occurred in the detailed survey area. Many of these subpopulations were less than 0.025 ha in area. For the 20 survey areas where Barstow woolly sunflower was found, population densities ranged from 0.04 to 5.11 individuals per square meter (Table 4).

Ninety-five percent (19 of 20 survey areas) of the Barstow woolly sunflower populations were found in zonal habitats of halophytic phase saltbush scrub with one survey area in Joshua tree woodland zonal habitat with halophytic phase saltbush scrub understory. The most common azonal habitat was clay pan, which were reported in 84 percent of the survey areas where Barstow woolly sunflower was found. Other azonal habitat found were dunes (3%) and rock outcrops and hillsides (13%). The majority of Barstow woolly sunflower populations (75%) were found in survey areas with alluvial plain geomorphology. Other geomorphologies found were hill, ridge, slope, alluvial fan, dune, and pan. Other plants observed in these areas include two varieties of saltbush (*Atriplex spinifera* and *A. confertifolia*), creosote bush (*Larrea tridentata),* Joshua tree *(Yucca brevifolia*), burro-weed *(Ambrosia dumosa*), *Schismus barbatus*, peppergrass, filaree (*Erodium cicutarium*), goldfields (Lasthenia chrysostoma), and *Chorizatzthe spinosa*.

Aspects in the population areas were often oriented to the north with slopes that were mostly flat, varying from 1 to 15 degrees, with a mean of 3.6 degrees. Populations occurred at elevations between 713 m and 796 m. Soil texture was a mix of fine and coarse particles, generally with a hard consistency and often gravelly at the surface. Clay- and silt soil textures were reported at 90 percent of the survey areas where Barstow woolly sunflower was found. The remaining survey areas where Barstow woolly sunflower was found had sand soil texture components.

Weather data for these surveys are summarized in Table 5, and show that minimum temperatures ranged from 12 to 29 degrees Celsius (C) with a mean of 19.02 degrees C, while maximum temperatures ranged from 13 to 29 degrees C with a mean of 22.58 degrees C. Wind speed ranged from 1 to 50 kilometers per hour (kph) with a mean of 17.77 kph. Cloud cover ranged from 0 to 100 percent with a mean of 36.15 percent.

Table 4
Densities of *Eriophyllum mohavense* Populations Observed During Spring 1995 Surveys

Survey Area	Transect ID	Type of Survey	Number of Individuals	Population Area (square meters)	Population Density (individuals/ square meter)
95RP004	95EM4001	Detailed	82,183	150,000	0.55
95RP014	95EM1003	Population Size	511	100	5.11
95RP036	95EM1002	Population Size	3,124	36,000	0.09
95RP401	95EM4002	Potential Habitat	215	600	0.36
95RP402	95EM403	Potential Habitat	355	100	3.55
95RP404	95EM4005	Potential Habitat	528	5,000	0.11
95RP406	95EM4014	Potential Habitat	183	300	0.61
95RP407	95EM4015	Potential Habitat	1,682	4,700	0.36
95RP409	95EM4020	Potential Habitat	478	12,500	0.04
95RP410	95EM4026	Potential Habitat	1,545	1,100	1.40
95RP411	95EM4028	Potential Habitat	168	500	0.34
95RP412	95EM4032	Potential Habitat	52	45	1.16
95RP413	95EM4033	Potential Habitat	801	14,500	0.06
95RP1001	95EM1001	Potential Habitat	906	200	4.53
95RP3003	95EM3001	Potential Habitat	2,702	3,100	0.87
95RP3005	95EM3006	Potential Habitat	2,694	8,400	0.32
95RP3006	95EM3011	Potential Habitat	306	1,000	0.31
95RP3008	95EM3012	Potential Habitat	29	400	0.07
95RP5054	95EM5010	Potential Habitat	142	50	2.84
95RP5056	95EM5011	Potential Habitat	156	1,500	0.10

Table 5
Summary of Weather Data for *Eriophyllum mohavense* Surveys

Date	Survey Area ID	Start Time	End Time	Max. Temp. (Celsius)	Min. Temp. (Celsius)	Max. Wind (kilometers per hour)	Wind Direction	Max. Percent Cloud Cover
3/15/95	95RP004	1100	1715	26	22	5	SE	20
3/16/95	95RP004	800	1330	28	15	5	W	70
3/17/95	95RP004	1615	1815	28	24	5	NW	60
3/18/95	95RP004	900	1745	26	17	30	SW	95
3/19/95	95RP004	800	1645	27	17	25	SW	50
3/20/95	95RP004	800	1700	24	16	35	SW	100
3/26/95	95RP004	800	1630	24	16	3	NW	1
4/4/95	95RP014	830	1100	22	16	2	NW	28
4/4/95	95RP404	930	1405	21	14	10	W	5
4/4/95	95RP403	1230	1500	25	22	3	SE	5
4/4/95	95RP406	1400	1630	22	21	20	W	40
4/4/95	95RP401	1500	1630	24	22	5	SW	10
4/4/95	95RP402	1630	1730	24	22	5	SW	5

Table 5. Page 2 of 3

Date	Survey Area ID	Start Time	End Time	Max. Temp. (Celsius)	Min. Temp. (Celsius)	Max. Wind (kilometers per hour)	Wind Direction	Max. Percent Cloud Cover
4/5/95	95RP405	1200	1445	24	22	15	W	35
4/6/95	95RP407	930	1200	22	16	25	W	75
4/6/95	95RP3003	1000	1415	27	21	50	W	85
4/6/95	95RP1001	1140	1430	21	18	25	W	90
4/6/95	95RP408	1300	1415	23	22	25	W	75
4/6/95	95RP3005	1415	1815	26	20	50	W	85
4/6/95	95RP409	1430	1700	20	19	25	W	80
4/6/95	95RP036	1500	1700	20	18	25	W	80
4/6/95	95RP3005	1700	1715	26	20	50	W	85
4/7/95	95RP410	900	1015	15	13	30	W	65
4/7/95	95RP036	900	1530	23	15	40	W	65
4/7/95	95RP411	1045	1230	20	17	25	W	70
4/7/95	95RP412	1300	1400	21	19	25	SW	60
4/7/95	95RP413	1530	1730	19	17	30	SW	70
4/9/95	95RP414	1230	1315	18	17	25	NW	25
4/9/95	95RP415	1315	1415	19	18	30	NW	25
4/9/95	95RP416	1430	1545	19	17	25	NW	25
4/9/95	95RP417	1545	1630	17	16	25	NW	25
4/11/95	95RP004	800	1730	23	15	1	N	50
4/12/95	95RP004	800	1615	22	16	8	W	90
4/13/95	95RP5001	844	953	19	12	6	SW	10
4/13/95	95RP5002	1012	1057	19	15	10	SW	10
4/13/95	95RP5003	1110	1145	20	20	15	SW	10
4/13/95	95RP5004	1200	1239	21	16	40	SW	10
4/13/95	95RP5005	1249	1330	22	18	45	SW	10
4/20/95	95RP3009	1500	1530	13	13	40	SW	30
4/21/95	95RP3011	900	1000	14	13	20	NW	5
4/21/95	95RP3006	1000	1200	18	14	20	NW	5
4/21/95	95RP3007	1230	1330	21	18	20	NW	5
4/21/95	95RP3008	1330	1500	21	20	20	NW	5
4/21/95	95RP3010	1500	1615	20	18	20	NW	5
4/22/95	95RP3012	1515	1600	29	27	5	N	0
4/22/95	95RP3013	1600	1645	29	29	5	N	0
4/24/95	95RP5054	945	1045	24	23	1	NW	0
4/24/95	95RP5055	1110	1144	26	25	2	NW	0
4/24/95	95RP5056	1155	1300	26	25	1	NW	0
4/24/95	95RP5057	1415	1450	26	25	2	NW	99.9
4/24/95	95RP5058	1503	1532	26	25	1	NW	0
4/24/95	95RP5059	1545	1625	26	26	3	W	97
4/24/95	95RP5060	1650	1723	25	25	6	W	95
4/25/95	95RP5061	850	950	19	18	8	S	0

Table 5, Page 3 of 3

Date	Survey Area ID	Start Time	End Time	Max. Temp. (Celsius)	Min. Temp. (Celsius)	Max. Wind (kilometers per hour)	Wind Direction	Max. Percent Cloud Cover
4/25/95	95RP5062	1003	1040	23	19	9	S	0
4/25/95	95RP5063	1105	1150	26	20	8	SW	0
4/25/95	95RP5064	1153	1230	27	20	8	SW	0
4/25/95	95RP5065	1326	1401	24	21	15	W	0
4/25/95	95RP5066	1431	1505	26	22	15	W	0
4/25/95	95RP5067	1600	1638	28	25	25	SW	0
5/3/95	95RP004	830	1600	18	14	5	SE	0
5/5/95	95RP004	745	1630	18	13	20	W	95

Surveys of Known Populations

Table 6 presents population data for the three known population surveys (one detailed survey area and two population size survey areas). All known population surveys were conducted in areas of halophytic phase saltbush scrub zonal habitat. Two of the three survey areas had clay pan azonal habitats and one had rock outcrop and hillside azonal habitat. Two of the three survey areas had alluvial plain geomorphology with the third survey area having hill and ridge geomorphology. Soil textures were dominated by clay components. Elevation of these survey areas ranged from 716 to 747 m. The two survey areas with alluvial plain geomorphology were nearly flat with northwest aspects, while the survey area with hill and ridge geomorphology had a slope of approximately 15 degrees and areas with aspects facing several directions in different portions of the population (west, south, and southeast).

Detailed Survey Area

One previously known population of Barstow woolly sunflower was surveyed in detail (Figure 11). This population was estimated at a total of 82,183 plants and accounted for approximately 83 percent of the total number of plants found during these surveys. During Observation A, a total of 61,030 Barstow woolly sunflower individuals were counted. Subpopulations were broadly distributed and ranged in size from 4 to 9,039 plants.

During Observation B, a total of 82,183 Barstow woolly sunflower plants were estimated at this survey area, a 35 percent increase from Observation A. A total of 16,909 plants were counted in the 10 subpopulations randomly chosen to be resampled. Five new subpopulations located during Observation B contained 1,102 plants. An additional 521 plants were counted in areas that were extensions of six of the original subpopulations. The additional 1,623 plants were used in calculating the estimate of the number of individuals during Observation B.

Table 6

Summary of *Eriophyllum mohavense* Known Population Surveys

Survey Area	Transect ID	Observation ID	Figure Number	Survey Type	Number of Individuals	Population Area (hectares)	Area Surveyed (hectares)	Zonal Habitat	Azonal Habitat	Geomorphology	Soil Texture	Elevation (meters)	Slope Angle (%)	Slope Aspect
95RP004	95EM4001	A	7	Detailed	61,030	15	15	HPSS	CLAY	ALLPLN	SLTCL	722	2	NW
95RP004	95EM4001	B	7	Detailed	82,183	15	15	HPSS	CLAY	ALLPLN	SLTCL	722	2	NW
95RP004	95EM4001	C	7	Detailed	23,009	15	15	HPSS	CLAY	ALLPLN	SLTCL	722	2	NW
95RP014	95EM1003	A	8	Population Size	511	0.01	1	HPSS	CLAY	ALLPLN	CL	747	2	NW
95RP036	95EM1002	A	5	Population Size	3,124	1.6	3.6	HPSS	RO	HILL, RIDGE	CLLM, GR	716	15	W, S, SE

Notes:

Zonal Habitat
HPSS = Halophytic phase saltbush scrub

Azonal Habitat
CLAY = Clay pans
RO = Rock outcrops and hillsides

Geomorphology
ALLPLN = Alluvial plain
HILL = Hille
RIDGE = Ridge

Soil Texture
CL = Clay
CLLM = Clay Loam
GR = Gravel
SLTCL = Silty clay

Aspect
NW = Northwest
S = South
SE = Southeast
W = West

During Observation C, a total of 23,009 individuals were estimated in the detailed survey area. This represents a 72 percent decrease from Observation B and a 38 percent decrease from Observation A. A total of 8,303 plants were counted in the 11 subpopulations randomly chosen to be resampled. No new subpopulations or subpopulation extensions were recorded during Observation C.

Barstow woolly sunflower was observed in distinct phenological stages during the three observations (Table 7). The majority of the measured sample during Observation A were in bud or bud and flower (70%), while nearly all of the remaining (23 %) were in the vegetative stage. During Observation B, 94 percent of the measured sample were in phenological stages that included flowers. At Observation C, 91 percent of the measured sample were in fruit or past the fruiting stage. Based on the estimate of the number of individuals during Observation B, 59 percent of the total population had already desiccated and were unidentifiable by this time.

The minimum and maximum individual plant heights recorded were 0.1 and 3.4 cm, respectively. Mean plant height varied from observation to observation, ranging from 0.42 cm to 0.77 cm (Table 8). The average diameter of the plant samples ranged from 0.60 to 1.19 cm (Table 8). The largest diameter reported for any plant was 3.0 cm. Analysis of the mean average diameter as a function of mean plant height (Figure 12) revealed that plants with larger diameter were not necessarily taller, at least not until late in the season. The mean distance to the nearest plant of the same species ranged from 1.34 cm to more than 33.43 cm (Table 8). The larger distances between plants were recorded during Observation C.

Table 7

Summary of Phenological Stage Data for *Eriophyllum mohavense* at the Detailed Survey Area on Edwards AFB Spring 1995

	Percent of Total with Confidence Interval[1]		
	Observation A	Observation B	Observation C
Phenological Stage	3/26/95	4/12/95	5/5/95
Vegetative	23.0 ± 8.3	0	0
Bud	32.6 ± 9.3	0.2 ± 0.9	0
Bud, Flower	37.8 ± 9.6	7.0 ± 5.1	0
Flower	6.6 ± 4.9	78.8 ± 8.1	8.2 ± 5.4
Bud, Flower, Fruit	0	0.8 ± 1.8	0
Flower, Fruit	0	7.4 ± 5.2	0.6 ± 1.5
Fruit	0	5.8 ± 4.6	32.2 ± 9.3
Unidentifiable (Dormant)[2]	0	0	59.0 ± 9.8
Total:	**100**	**100**	**100**

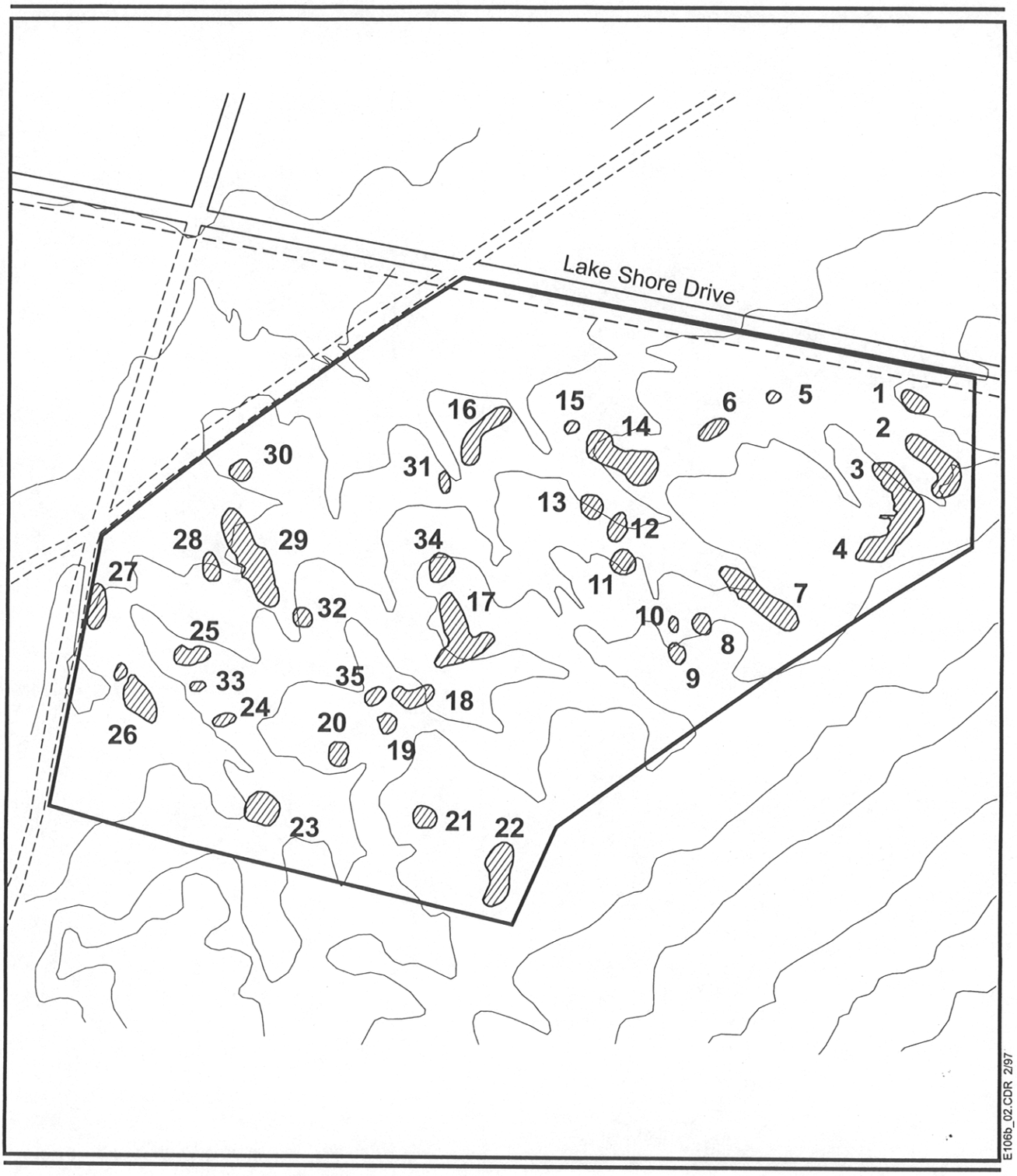
Notes: [1] Confidence interval is plus or minus 95 percent.
[2] Calculated based on Observation B.

Table 8

Plant Height, Average Diameter, and Distance to Nearest Plant of the Same Species *Eriophyllum mohavense* Detailed Survey Area Spring 1995

Observation/ Subpopulation No.	Plant Height (cm)			Average Diameter (cm)			Distance to Nearest Plant (cm)		
	Mean	Confidence Interval	Standard Deviation	Mean	Confidence Interval	Standard Deviation	Mean	Confidence Interval	Standard Deviation
Observation A 3/26/95									
17	0.66	0.03	0.15	0.83	0.08	0.40	6.41	1.05	5.26
25	0.60	0.04	0.18	0.61	0.07	0.34	7.83	2.14	10.75
29	0.61	0.03	0.14	0.64	0.07	0.35	8.65	2.29	11.47
9 and 10	0.54	0.04	0.18	1.06	0.10	0.48	6.89	1.54	7.72
1	0.73	0.02	0.12	1.13	0.10	0.49	5.75	1.19	5.96
Observation B 4/12/95									
2	0.74	0.04	0.20	0.77	0.07	0.36	9.52	2.37	11.90
9	0.67	0.03	0.17	0.92	0.09	0.43	8.74	2.70	13.46
11	0.64	0.03	0.16	0.60	0.06	0.28	5.40	0.83	4.15
14	0.72	0.03	0.14	0.71	0.05	0.24	1.34	0.13	0.65
21	0.75	0.05	0.24	1.19	0.09	0.46	3.79	0.69	3.46
Observation C 5/5/95									
3	0.48	0.04	0.21	0.91	0.07	0.36	32.38	21.57	108.18
8	0.46	0.04	0.19	0.98	0.08	0.40	33.43	21.13	105.96
23	0.54	0.03	0.16	0.95	0.06	0.32	14.80	5.01	25.10
26	0.42	0.03	0.14	0.86	0.06	0.28	3.01	0.56	2.83
33 and 34	0.77	0.06	0.29	1.07	0.08	0.38	18.74	8.09	40.57

Note: Confidence interval is plus or minus 95 percent.



Subpopulation Area and Number

Locations of Subpopulations at the Lakeshore Drive Detailed Survey Area

200 0 200 Feet

Figure 11

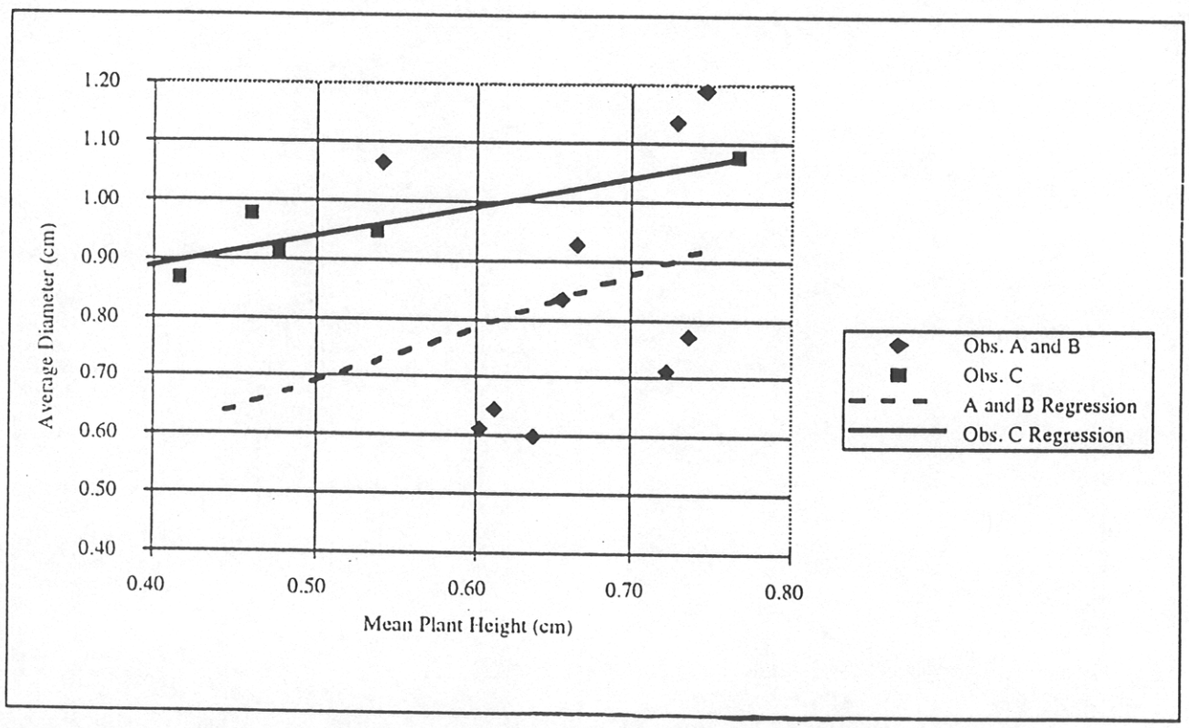


Figure 12. Mean Average Diameter as a Function of Mean Plant Height for all Observations of *Eriophyllum mohavense* at the Detailed Survey Area on Edwards AFB, March through May 1995

Population Size Surveys

Two population size surveys were conducted (Table 5). In one survey area, northwest of Leuhman Ridge, 1 ha was surveyed, and a population of 511 individuals was counted in an area of about 0.01 ha. In the other area, near Buckhorn Lake, an area of 3.6 ha was surveyed and approximately 3,124 plants were found in 1.6 ha.

Potential Habitat Surveys

Table 9 presents data collected for the 47 potential habitat survey areas. Seventeen of these 47 potential habitat survey areas were found to contain Barstow woolly sunflowers. Sixteen of the potential habitat survey areas in which Barstow woolly sunflower was found had halophytic phase saltbush scrub as their zonal habitat. One survey area had Joshua tree woodland as the zonal habitat. The most common azonal habitat in the potential habitat survey areas where Barstow woolly sunflower was found was clay pans, recorded in 88 percent of the survey areas. The remaining 12 percent of these survey areas contained dune and rock outcrop and hillside azonal habitat. The dominant geomorphology found in the survey areas where Barstow woolly sunflower was found was alluvial plain, recorded in 77 percent of the survey areas. Other geomorphologies recorded were slope, hill, alluvial fan, dune, and pan. Soil textures in the survey areas where Barstow woolly sunflower was found were dominated by silt and clay components often with a gravelly or rocky surface texture. Elevation of these survey areas ranged from 713 to 796 m. Slopes were nearly flat averaging 3 percent with aspects ranging from west, northwest, north, northeast, and southeast. Three of these aspects, northwest, northeast and west together account for the recorded aspect in 85 percent of the survey areas where Barstow woolly sunflower was found, Northwest was the most prevalent aspect, recorded in 35 percent of the survey areas. Northeast and west were recorded as the aspect in 29 and 21 percent of the survey areas respectively. The remaining survey areas contained aspects of southeast and north.

Incidental Detections

Four other sensitive plant species were found during Spring 1995 surveys for Barstow woolly sunflower: *Cymopterus deserticola*, a federal category 1 candidate species and CNPS list 1B species; and *Chorizanthe spinosa*, *Muilla coronata*), and *Goodmania luteola*), all CNPS watch list species. No incidental detections of Barstow woolly sunflower occurred during Spring 1995 surveys for other sensitive plant species.

DISCUSSION

In 1995, Barstow woolly sunflower was found in higher numbers of individuals and in more population areas on Edwards AFB than was previously known. The current survey documented 15 and 20 times the number of plants

Table 9
Summary of Eriophyllum mohavense Potential Habitat Surveys

Study Area	Transect ID	Figure Number	Number of Individuals	Population Area (hectares)	Area Surveyed (hectares)	Zonal Habitat	Azonal Habitat	Geomorphology	Soil Texture	Elevation (meters)	Slope Angle (%)	Slope Aspect
95RP401	95EM4002	7	215	0.06	13.5	HPSS	CLAY	ALLPLN	CLLM, GR	719	7	SE
95RP402	95EM403	7	355	0.01	6	HPSS	CLAY	SLOPE, ALLPLN	CLLM, GR	725	3	NE
95RP403	NA	7	0	0	20.14	JTW	CLAY	ALLPLN	SND	719	2	NW
95RP404	95EM4005	8	528	0.5	16	HPSS	CLAY	ALLPLN	CL	768	3	W
95RP405	NA	8	0	0	16.24	HPSS	CLAY	SLOPE, ALLPLN	SNDCL	780	4	W
95RP406	95EM4014	8	183	0.03	6.75	HPSS	CLAY	ALLPLN	CL	786	1	NW
95RP407	95EM4015	9	1,682	0.47	8	HPSS	CLAY	ALLPLN	SLTCL	792	1	NE
95RP408	NA	9	0	0	7.25	CBS	None	ALLPLN	SNDCL	780	1	N
95RP409	95EM4020	9	478	1.25	8	HPSS	CLAY	ALLPLN	SLTCL	777	1	NE
95RP410	95EM4026	9	1,545	0.11	4	HPSS	CLAY	ALLPLN	SLTCL, GR	796	2	N
95RP411	95EM4028	9	168	0.05	8	HPSS	CLAY	ALLPLN	SLTCL, GR	768	1	NE
95RP412	95EM4032	9	52	0.0045	4	HPSS	CLAY	SLOPE, ALLPLN	SLTCL, GR	771	3	NE
95RP413	95EM4033	8	801	1.45	10	HPSS	CLAY	ALLPLN	SLTCL,GR	774	1	NW
95RP414	NA	8	0	0	7.44	CBS	CLAY	SLOPE	SLTCL	744	2	NW
95RP415	NA	8	0	0	7.74	CBS	CLAY	SLOPE	SLTCL	762	2	NW
95RP416	NA	8	0	0	4.21	JTW	CLAY	SLOPE	SLTCL	774	3	N
95RP417	NA	8	0	0	3.08	HPSS	CLAY	ALLPLN	SLTCL	777	0	NA
95RP1001	95EM1001	5	906	0.02	0.2	HPSS	RO	HILL	CLLM, GR	713	10	S, W
95RP3003	95EM3001	8	2,702	0.31	10	HPSS	None	ALLPLN	SLTCLLM, GR	759	7	W
95RP3005	95EM3006	8	2,694	0.84	10	HPSS	None	SLOPE, ALLPLN	CLLM, GR	768	4	W
95RP3006	95EM3011	6	306	0.1	8	HPSS	None	HILL, ALLFAN	GR	713	2	NW
95RP3007	NA	6	0	0	7.24	HPSS	None	HILL, PAN	SLTCL, SND	710	4	N
95RP3008	95EM3012	6	29	0.04	8	HPSS	None	HILL, ALLFAN	GR	713	2	NW
95RP3009	NA	7	0	0	1.78	HPSS	CLAY	ALLPLN	SLTCL	732	3	N
95RP3010	NA	7	0	0	7.85	HPSS	None	PAN, ALLPLN	SLT, GR	707	2	W
95RP3011	NA	6	0	0	5.87	HPSS	None	HILL, PAN	GR, SLTCL	701	5	NW
95RP3012	NA	7	0	0	2.07	HPSS	None	ALLPLN	SND, GR	719	2	NW
95RP3013	NA	7	0	0	2.13	HPSS	None	ALLPLN, PAN	GR, SLTCL	713	3	SW
95RP5001	NA	10	0	0	9.13	HPSS	None	ALLPLN, PAN	SND	851	1	NE

Table 9, Page 2 of 2

Study Area	Transect ID	Figure Number	Number of Individuals	Population Area (hectares)	Area Surveyed (hectares)	Zonal Habitat	Azonal Habitat	Geomorphology	Soil Texture	Elevation (meters)	Slope Angle (%)	Slope Aspect
95RP5002	NA	10	0	0	8.69	HPSS	None	ALLPLN	SND	853	3	S
95RP5003	NA	10	0	0	6.06	HPSS	None	ALLPLN	SND	853	2	SW
95RP5004	NA	10	0	0	6.1	APSS	CLAY	ALLPLN	SND	853	1	E
95RP5005	NA	10	0	0	6.29	CBS	CLAY	ALLPLN	SND	860	0	NA
95RP5054	95EM5010	8	142	0.005	8	HPSS	None	PAN, DUNE	SLTCLLM	774	3	NW
95RP5055	NA	8	0	0	7.37	CBS	DU	DUNE, ALLPLN	SNDCL	774	2	NW
95RP5056	95EM5011	8	156	0.15	8	JTW	CLAY, DU	ALLPLN	SNDCL	777	1	NW
95RP5057	NA	8	0	0	5.81	JTW	CLAY	ALLFAN	SNDCL	762	1	W
95RP5058	NA	8	0	0	3.64	APSS	None	PAN, ALLPLN	SND, SLTCL	756	1	S
95RP5059	NA	7	0	0	7.69	HPSS	CLAY	ALLPLN	SNDCL	716	1	NW
95RP5060	NA	7	0	0	3.94	HPSS	None	PAN, ALLPLN	CLLM	713	1	NW
95RP5061	NA	8	0	0	7.36	JTW	CLAY	ALLPLN	SND, GR	738	4	S
95RP5062	NA	8	0	0	8.94	JTW	CLAY	ALLPLN, PAN	SND, SLTCL	762	3	SW
95RP5063	NA	7	0	0	6.66	HPSS	CLAY	DUNE, ALLPLN	SNDCL	713	6	SE
95RP5064	NA	7	0	0	6.69	HPSS	None	DUNE, ALLPLN	SNDCL	710	3	NE
95RP5065	NA	7	0	0	6.59	HPSS	CLAY	ALLPLN	SNDCL	707	0	NA
95RP5066	NA	7	0	0	5.24	JTW	CLAY	ALLPLN	SND, GR, SLTCL	710	0	NA
95RP5067	NA	5	0	0	1.57	HPSS	CLAY	HILL, ALLPLN,PLAYA	SNDCL, GR	701	6	N

Notes: NA = not applicable

Zonal Habitat
APSS = Arid phase saltbush scrub
CBS = Creosote bush scrub
HPSS = Halophytic phase saltbush scrub
JTW = Joshua tree woodland

Azonal Habitat
CLAY = Clay pans
DU = Dunes
RO = Rock outcrops and hillsides

Geomorphology
ALLPLN = Alluvial plain
ALLFAN = Alluvial fan
DUNE = Dine
HILL = Hill
PAN = Pan
PLAYA = Playa
SLOPE = Slope

Soil Texture
CL = Clay
CLLM = Clay Loam
GR = Gravel
SLT = Silt
SLTCL = Silty clay
SLTCLLM =Silty clay loam
SND = Sand
SNDCL = Sandy clay

Aspect
N = North
NE = Northeast
NW = Northwest
S = South
SE = Southeast
SW = Southwest
W = West

reported in 1992 at the two sites with previously reported data. The current survey also documented 17 new populations on the base. Increases in the number of sites and numbers of plants are probably due to the drought conditions from the late-1980s through 1994 when some surveys were conducted (Charlton 1993b), and the increased precipitation and favorable weather conditions during the 1995 season, which yielded an apparent increase in the number of sites and plants. There have been few surveys for Barstow woolly sunflower conducted in the past, and most of the previous surveys were conducted in less favorable weather conditions. The Spring 1995 surveys are the first to calculate the plant density (number of individuals per unit area) for the Barstow woolly sunflower populations on Edwards AFB. This survey could be used as a baseline against which future surveys could be compared. These future studies could examine if any changes in the densities of these populations of Barstow woolly sunflower could be associated with weather conditions or other factors.

Population counts for Barstow woolly sunflower at the detailed survey area show a substantial increase in the numbers of plants from Observation A to Observation B and a substantial decrease from Observation B to Observation C, which documents the short time frame in which individual Barstow woolly sunflower plants complete their life cycle.

The population increase from Observation A to Observation B and the reported phenological stages of the measured sample (all were in bud, flower or fruit) suggest that there may have been small, nonflowering individuals present at Observation A that were not detected. By Observation B, these plants had grown larger and were in flower, making them easier to detect and count. The advanced phenological condition of more than 90 percent of the plants observed during Observation C provides evidence that the population decrease observed from Observation B to Observation C was due to plants completing their life cycle by setting seed (fruit stage), desiccation, then the broken parts being dispersed by the wind. Because Barstow woolly sunflower is difficult to detect when flowers are not evident, an accurate census of this species is best obtained during the flowering period. Future monitoring for this species should consider this factor. The flowering period at the Lakeshore Drive detailed survey area occurred several weeks earlier during this survey than in surveys conducted in 1992 (Charlton 1993b). The variation in flowering period has been observed in other Barstow woolly sunflower sites and is a general pattern for desert annuals. Because of this variation, any future surveys should be conducted in March, April, or May when flowering is expected, but the precise timing for any given year cannot be predicted more than a few weeks in advance. Plants with larger diameter were not necessarily taller, at least not until late in the season. The results could be explained by the observation that plants do not begin to grow dramatically in height until flowering ceases and are correlated with the fact that plant height was significantly different between Observations B and Observation C.

Zonal and azonal habitats where Barstow woolly sunflower was found were very consistent throughout the survey areas. Halophytic phase saltbush scrub was the zonal habitat in 95 percent of the survey areas and clay pans were the azonal habitat in 85 percent of the survey areas. This suggests that halophytic phase saltbush scrub zonal habitat could be considered as important habitat for Barstow woolly sunflower. In the potential survey areas where Barstow woolly sunflower was not found(Table 9) there was a great diversity of zonal habitats recorded. Fifty-six of the survey areas had halophytic phase saltbush scrub recorded as the zonal habitat which means that 43 percent of these survey areas contained different zonal habitats than halophytic phase saltbush scrub. This is a substantial number when compared to the single area without halophytic phase saltbush scrub as the zonal habitat in the survey areas where Barstow woolly sunflower was found. Clay pan azonal habitat, although the major azonal habitat recorded in areas where Barstow woolly sunflower was found, was also found in a similar number of survey areas where Barstow woolly sunflower was not found. Although clay pan azonal habitat may be an important habitat for Barstow woolly sunflower, this survey did not show this. Barstow woolly sunflowers found on Edwards AFB occurred mainly in areas with alluvial plain geomorphology which is consistent with previous observations and shows that this geomorphology may be an important habitat characteristic for Barstow woolly sunflower.

Previous reports indicated that peppergrass and *Chorizanthe spinosa* are common associates of the Barstow woolly sunflower (Skinner and Pavlik 1994; Charlton 1993b). The current survey reported peppergrass in 10 of the 20 survey areas (50%) where Barstow woolly sunflower occurred, and *Chorizanthe spinosa* was recorded in 14 of these survey areas (70%). Peppergrass was only found in 4 of the 30 survey areas (13%) where Barstow woolly sunflower did not occur, and *Chorizanthe spinosa* was only recorded in 5 of those survey areas (17%). Although these surveys were not designed to determine indicator species, these species may be good indicator species for the Barstow woolly sunflower.

The population on the hills adjacent to Buckhorn Lake appears to be unusual because it occurs on top of a rocky butte. Munz (1974) indicated that other known populations do not occur in rocky places or in washes. They typically occur in very firm sandy clay loam or sandy-silty soils, often with some coarse sand and fine gravel on the surface. A soils study of Barstow woolly sunflower populations was conducted on several populations in the vicinity of Kramer Junction (ERT 1988b). The study found that there were distinct and consistent differences between soils sampled on low knolls that supported Barstow woolly sunflower populations and adjacent areas that did not. Major soil differences occurred from about 2 to 24 inches deep. The soils that supported Barstow woolly sunflower populations had an A layer (2 to 6 inches) with more clay (gravelly sandy clay loam), high alkalinity and boron, and a massive structure. The A layer was underlain by a more massive layer with elevated layers of salts, carbonates, alkalinity and boron. Barstow woolly sunflower appears to tolerate the relatively high alkalinity and boron found in the upper horizons of the soil. The more massive horizon (> 6 inches) was absent in areas without Barstow woolly sunflower. The more massive horizon apparently restricts the roots of shrubs from penetrating,

thereby creating the open areas where Barstow woolly sunflower typically grows. As a small, short-lived annual, the root system becomes adequately established in the zone overlaying the more massive horizon. A shallow surface layer of gravelly sandy loam, with moderate alkalinity and slightly hard consistency occurred in the upper 2 inches of both soils that supported and conversely did not support Barstow woolly sunflower.

Weather conditions did not appear to have any effect on the detection of individuals or populations although conditions varied greatly throughout the survey period. Maximum and minimum temperatures differed as much as 17 degrees C throughout the survey period. Wind direction was fairly consistent throughout the survey period (from the southwest or west) with wind speeds varying from 1 to 50 kilometers per hour.

The newly reported Barstow woolly sunflower populations were found within the previously reported geographic range of the species on the base. The distribution of populations was scattered, and additional populations may occur in areas not surveyed. The northeastern portion of the base, from Kramer Junction west to Rogers Lake, appears to have the greatest potential for additional populations. Additional surveys in habitats similar to those which support the two populations on the hills adjacent to Buckhom Lake could also be informative. Two populations on the hills adjacent to Buckhom Dry Lake were found in an area with steeper slopes (10 to 15 degrees) and different habitat features (rock outcrops and hillsides) than have been previously identified (Charlton 1993b).

Many areas in the western portion of the base were not surveyed and may contain potential habitat for Barstow woolly sunflower. Additional surveys could be conducted in this part of the base to determine the presence or absence of Barstow woolly sunflower. Further quantitative studies could be conducted to determine whether there are indicator species (such as pepper grass or Mojave spineflower) and indicative geomorphic and soils components that could be used to predict the occurrence of Barstow woolly sunflower.

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